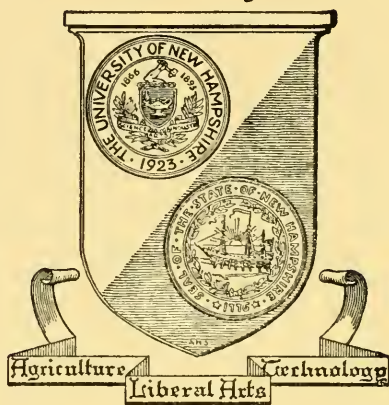


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AGRICULTURAL EXPERIMENT STATION

PROGRESS OF AGRICULTURAL
EXPERIMENTS—1923

A Report of the Director of the New Hampshire
Agricultural Experiment Station for the Year 1923,
including a Financial Statement for the Fiscal
Year Ending June 30, 1923



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PROGRESS OF AGRICULTURAL EXPERIMENTS, 1923.

A Report of the Director of the New Hampshire Agricultural Experiment Station for the Year 1923, Including a Financial Statement for the Fiscal Year Ending June 30, 1923.

The fundamental need of new research—particularly of soil investigations throughout the state—which was outlined in the last annual report of the New Hampshire Agricultural Experiment Station, has become more apparent during the past year—so much so that I am tempted to dwell upon it at once before reporting on the work in the various projects.

It is undoubtedly true that the next decade is to see radical changes in the state's agricultural industry. The volume of business has been too small on the average New Hampshire farm to compete with modern production. On the other hand, the nearness to market and the cheapness of land seem inevitable causes of expansion in certain regions. New economic conditions demand a thorough understanding of the resources of the state; and perhaps in no respect is the problem so complex and so difficult as in regard to the soil types and requirements.

The glacial action which determined the character of New Hampshire left the state with a variety of soils. The response of these soils to various crops and to varying fertilizer treatments can be determined, but it can be determined only by careful scientific research. Experimental plots at Durham suffice only for the particular types of soil found there; they are not a true criterion for the intervale land of the two big river valleys of the state, the upland soils of the interior, nor the warm hillsides of the lake region. Nor are general farm practices or extension demonstrations a sound guide here. This is a time when farm practice is shifting; and the question itself is to what foundation the shift should be made. Extension demonstrations are valuable as lessons of truth already learned; but the plain fact is that some of our most important soil-and-crop problems have not yet been satisfactorily solved. They can be solved, in our judgment, only by a thorough-going system of plat work conducted in representative areas, and carefully supervised over a period of years. It is exceedingly unfortunate that such work has already been overdelayed by lack of additional funds.

The importance of these investigations has been strikingly shown during the past year in the survey which the Experiment Station has been conducting of the lime sources of the state. It has not been commonly realized that any of the soils were of limestone origin; yet in tracing the outcroppings of lime along some of the ridges of the Connecticut Valley, the influence of the deposits on the lowlands near the river is very strongly suggested. Such an influence is bound to be an important factor to weigh in recommendations for agricultural practice in that region. This is only an instance of what soil investigations should mean.

By instituting experimental plat work in typical areas a considerable saving in time, as well as efficiency, could be effected over the present process. It is now necessary to make experiments at the University and then to repeat them

under "field conditions" before making general recommendations. At the best a year is lost by this process over a system by which the experiments could at once be put on in the field.

Another advantage of the field plats is that they would carry their lessons into the midst of farmers more effectively than is at present possible, having an even greater importance than ordinary demonstrations. Extension meetings could readily be held at such plats, and the value of them thus quickly realized.

The need of great care in drawing conclusions and the necessity for accurate, scientific study in such work is illustrated by the experience this past year with the soil rejuvenation plots which have been initiated at Durham. The general plan of these calls for four quarter-acre plots, each divided into five sections for different fertilizer treatment. The entire experiment is repeated on duplicate plots—an elaboration which would hardly be attempted in demonstrations, but which is essential for primary conclusions. Furthermore, the experiment is given an additional safeguard by repeating it on different land starting with a new season. Such care showed itself justified by the results during the past year. The plots exhibited marked variations. From one series alone the conclusions that might have been drawn would have been erroneous when viewed in the light of all of them. It is only by taking them all into account and studying the results carefully that the proper deductions may be made. This is why it is most important that the original experiments, from which extension demonstrations are later developed, should be conducted with scientific care.

In addition to the soil investigations other problems are greatly in need of research attention. Principal among these is the matter of marketing methods. A great deal of interest in the solution of this has already been aroused; and progress in co-operative marketing has been made. It has been necessary to make this progress, however, on the basis of conditions found elsewhere. The problems peculiar to New Hampshire communities have never been attacked by special investigation. Such questions as community production and distribution, the production of crops for a special market, the supplying of the summer resort trade, and others deserve careful inquiry; and the Experiment Station should be in a position to give fairly definite answers to them.

With the development of the Extension Service, the Experiment Station is finding it more and more important to direct its larger investigations to the leading projects to which that Service is committed. The lime-legume project, for example, has brought up the question of lime sources within the state. The potato project has from the start been founded upon experimental research. The Station also supplements regular extension projects with its fruit investigations, studies of the root maggot, corn borer, nutrition research, etc. Already as a result of its work with white diarrhea the elimination of that disease in the state is near.

PUBLICATIONS.

The following publications were issued during the year:

- Station Bulletin No. 205—Inspection of Commercial Feeding Stuffs for 1922.
“ “ “ 206—Inspection of Commercial Fertilizers for 1922.
“ “ “ 207—Results of Seeds Tests for 1922.
“ “ “ 208—Progress of Agricultural Experiments, 1922 (Director's Report).
Technical Bulletin No. 22—Experiments on the Field Control of Snapdragon Rust together with a Description of the Method for the Control of the Disease in Greenhouses.
Technical Bulletin No. 23—Effects of Shading on the Chemical Composition of Some Horticultural Plants.
Technical Bulletin No. 24—Surface Treatments for the Cabbage Maggot.
Technical Bulletin No. 25—Inheritance of Size and Conformation in Sheep.
Scientific Contribution No. 19—Effect of External and Internal Factors on the Germination of Fungus Spores.

Through the news service, which is conducted in co-operation with the Extension Service, much information is furnished to newspapers and farm journals regarding research work at the Station. Special articles on investigational activities have appeared on the farm page of the *Manchester Union*, in the *Granite Monthly*, and many other state publications in addition to those outside New Hampshire.

There have been few changes in personnel during the year. Mr. W. L. Doran resigned as assistant botanist on April 15, 1923; and since the close of the fiscal year the position has been taken by Dr. L. J. Klotz. Mr. C. P. Spaeth, assistant chemist, was granted leave of absence for three months during the year to pursue graduate study at the University of Pennsylvania. He received the degree of Master of Science at the University of New Hampshire in June. Mr. O. H. Pearson was appointed graduate assistant in the Horticultural Department on September 1, 1923.

Among the additions to equipment during the year were a new Pickel extraction apparatus for making fat determinations in the feed inspection work, an appplanatic condenser, an oil emersion lens, and a Freas drying oven.

The report on the work for the past year will be considered by projects under the headings of the main types of funds. Adams Fund projects are required by federal legislation to deal with the underlying causes of agricultural phenomena, and hence are more technical in their nature. Projects carried on under the Miscellaneous Fund are ones which through fees are either in whole or in large part self-supporting.

RESULTS OF WORK IN ADAMS PROJECTS.

Plant Metabolism Studies.

The relation of plant metabolism to fruit production recently has received a great deal of attention on the part of physiologists, biochemists, horticulturists and others interested in the study of plants. It has been shown that

there is a quite definite relation between the relative proportion of available nitrogenous compounds and carbohydrates to growth and reproduction. It is not surprising, therefore, that it has been possible, on the basis of the internal changes produced in the plants, to explain the effect upon fruitfulness of various cultural operations such as pruning, fertilization with nitrogen, cultivation, growing of cover crops, etc. In fact, more rational recommendations regarding cultural operations in fruit production can be hoped for only by means of a thorough understanding of the internal changes produced and their correlations with external manifestations of the plants.

If the other environmental conditions are maintained, increases in the amount of available nitrogen lead to a decrease in the proportion of available carbohydrates. This is in part due to the fact that considerable amounts of carbohydrates are used up with the nitrogen in the synthesis of proteins. Any decrease in the supply of available nitrogen on the other hand will lead to an increase in the relative proportion of carbohydrates. This is in large part due to the fact that the carbohydrates are not used up with the nitrogen in the synthesis of proteins. Phosphorus and sulphur are also used in the synthesis of proteins. It would be helpful, therefore, to know in what manner modifications of the supply of phosphorus and sulphur affect growth and reproduction as well as the metabolism of the plant.

The present project was initiated by H. R. Kraybill and T. O. Smith (Agricultural Chemistry) with the purpose of studying the effect of modifying the supply of nitrogen, phosphorus and sulphur upon growth and fruit production. The tomato plant has been used in all of the work. In addition to the two sets of plants mentioned in the last report another set has been grown during the past year. Analysis of the first two sets of plants has been completed and that of the third set is now under way. Careful records have been made of the number of blossom clusters formed and the number of fruits set on each blossom cluster. Microchemical and anatomical studies have been made.

The results with the first two sets show that the plants which were grown in a fertile soil and then transplanted to sand with a nutrient solution minus phosphorus were feebly vegetative, deep green in color, and non-fruitful. Compared with those grown in the complete nutrient solution they were higher in total nitrogen, nitrate nitrogen and chlorophyll content and also higher in free reducing sugars and total carbohydrates. The plants grown in sand with nutrient solution minus nitrogen were also feebly vegetative and non-fruitful, but had a pale green color and compared to those grown in the complete nutrient solution were lower in total nitrogen, nitrate nitrogen and chlorophyll content, and higher in free reducing sugars and total carbohydrates.

The plants grown in sand with nutrient solutions minus sulphur were just slightly less vegetative and fruitful than those grown in the complete nutrient solution, and were slightly higher in total nitrogen, free reducing substances and total carbohydrates. The effect of leaving the sulphur out of the nutrient solution was not very marked.

In order to study in more detail the effect of limiting the supply of phosphorus and sulphur upon the metabolism of the plants, the nitrogen distribution of the three fractions, separated by a modification of the Koch method of tissue analysis, was determined.

Compared with those grown in the complete nutrient solution, those grown in the nutrient solution minus phosphorus are much lower in insoluble nitrogen, higher in soluble nitrogen and slightly higher in lipid nitrogen.

The plants grown in the nutrient solution minus nitrogen are feebly vegetative and non-fruitful. Those growing in the nutrient solution minus phosphorus show a similar effect, but the former are high in total nitrogen and nitrate nitrogen, while the latter are low in total nitrogen. An examination of the form of the nitrogen present shows that the plants grown with the nutrient solution minus the phosphorus, while high in total nitrogen and nitrate nitrogen, are low in synthesized or protein nitrogen and that the plants grown with nutrient solution minus nitrogen are also low in protein nitrogen.

The effects of limiting the supply of phosphorus upon growth and reproduction may be explained in part at least by the effect on protein and carbohydrate metabolism.

The very marked effect of large applications of available phosphorus in increasing fruitfulness and hastening maturity of the tomato has been shown in field experiments as related on page 27.

Fruit Bud Formation.

Work on this project has been carried on in the Woodman Orchard as in previous years by G. F. Potter and S. W. Wentworth (Horticulture), and additional data are now being obtained from the Renovated Orchard at the Horticultural Farm.

In the Woodman Orchard Baldwin trees under sod mulch without additional fertilizer, trees under cultivation where no cover crop is planted, trees which receive good culture including cover crop but no fertilizers, and trees which are under the cultivation cover crop system supplemented with complete chemical fertilizer, are under comparison. The experiment is now in its sixteenth season. It has previously been reported that the addition of fertilizers produced no significant increase in the crop during the first ten years of the experiment. Some differences in growth were recorded and these differences are still apparent. The trunk diameter, which is a fair index of the total development of the tree, averages 15.1 inches on those plots receiving fertilizer in addition to cultivation and cover crop; 14.4 on the plot which is cultivated and receives a cover crop each season; 13.5 inches on the plot cultivated without a cover crop; and 12.1 inches on the sod plot.

In recent years, increases in yield on the fertilizer plots have been reported approximating 50 per cent more than those not fertilized, and a very significant difference is apparent in the state of the trees. The unfertilized trees are declining in vigor very rapidly. It has been customary to drop out of each plot any tree which becomes weak and no longer able to produce normal crops of fruit. During the season of 1922, nine trees were dropped, because of their weakened condition, from the plots which receive no fertilizer. Only one tree was dropped from those plots which receive fertilizer. The yield data for the season of 1922 are of little significance as there was practically no crop. The highest average production was on Plot 4, which averaged 82 pounds per tree. A good yield for Baldwin trees comparable in size to those

in this experiment would be about 600 to 700 pounds per tree. The low yields for the season of 1922 may be explained in two ways. Weather conditions during the season of 1921 were very dry and apparently unsuited to fruit bud formation. During the winter of 1921-22, ruffed grouse entered this orchard from adjoining woods and "budded" the trees, resulting in a still further decrease in the crop.

No data were taken on the number of buds stripped from the trees by the grouse during the winter of 1921-22 because the seriousness of the situation was not realized until too late. The ruffed grouse attacked the orchard again during the winter of 1922-23. On March 1, 1923, an estimate was made as to the proportion of buds missing in the orchard, and it was found that as an average for all the trees, 36.5 per cent of all the buds on side branches had been removed and 52.3 per cent of all the buds on top branches.

The budding was fairly uniform over the entire orchard. On the plots that received no fertilizer, which are farthest from the woods, counts indicate that 31 per cent of the buds on side branches were missing and 53 per cent of the buds on top branches. This is practically the same as the average for the entire orchard. The budding problem has been so serious in New Hampshire during the past two seasons that a special project in relation to injury to orchard trees by ruffed grouse has been organized under the Hatch funds.

The crop of 1923 completes the third five-year period under which records of yield have been taken upon this experiment. It was expected that the data would be worthy of publication, but owing to the reduction in yield due to budding by the grouse it does not seem worth while to make the summary at this time. During the coming winter sprays will be used in an attempt to repel the birds from the trees, and if the difficulty can be overcome the experiment will be reported upon after one or more additional normal crops have been obtained. The plan to obtain data on regularity of production of the fruit spurs has been rendered impracticable by the removal of a large proportion of the old fruit spurs on the trees by the birds.

In the Renovated Orchard at the Horticultural Farm a very fair yield of fruit was obtained in 1923. In this orchard the yield and fruit bud formation are compared on mature Baldwin trees which are under cultivation with cover crop and which receive additional applications of nitrate of soda in some plots and of complete fertilizer in other plots, with trees which receive the same fertilizer treatments but which are under the sod mulch system of culture. While this experiment is very limited, there being only seven trees in each plot, it appears to demonstrate the value of the sod mulch system of culture where five pounds of nitrate of soda per tree is given as an annual spring application. The seven trees under this treatment are equal to any other plot in the orchard in vigor and in production. In interpreting this data one must bear in mind, of course, the fact that the yields of any orchard for one season cannot be considered very significant.

Relation of Light to Fruit Bud Formation.

Composition of Fruiting and Non-Fruiting Spurs.

The laboratory work on the chemical conditions associated with fruit bud formation in apple spurs has been carried on by Messrs. Potter and Wentworth

in co-operation with H. R. Kraybill (Agricultural Chemistry). Practically all of the work on the fruit spurs which were sampled during the year of 1921 has been completed and this phase of the project is nearly ready for publication.

During the period of most active fruit bud formation, the spurs on the non-fruiting sod plats, 10 per cent of which formed fruit buds, were lowest in total nitrogen; those of the fruiting sod plats, none of which formed fruit buds, and those of the non-fruiting nitrate plats, 44 per cent of which formed fruit buds, were medium in total nitrogen; and those of the fruiting nitrate plats, one-half of one per cent of which formed fruit buds, were highest in total nitrogen. At this same time the spurs from the non-fruiting sod plats were highest in starch; those from the non-fruiting nitrate plats, medium in starch; and those from the fruiting sod plats and the fruiting nitrate plats were lowest in starch.

It has been believed that a condition of high starch and low nitrogen content of the spurs during the time of fruit bud formation is essential for fruit bud formation. Apparently other conditions are necessary also, since the non-fruiting nitrate plat spurs, which had about the same total nitrogen content as the non-fruiting sod plat spurs, were lower in starch and produced about 44 per cent of fruit buds, while those of the sod plats produced only 10 per cent. An examination of the starch and total nitrogen analyses for the entire season shows that the spurs from the trees grown in sod are in general lower in total nitrogen and higher in carbohydrates than the spurs from the trees grown on the nitrate plats.

Effect of Defruiting upon Chemical Composition and Fruit Bud Formation.

During the season of 1922 the fruit spur composition project was carried on using fruit spurs from Duchess trees in the Thompson Orchard. In this experiment it was planned to base the investigation upon the known fact that if a fruit spur is deflorated at about the time the blossoms open or when they are in the pink bud stage, it will usually form flower primordia the same season; whereas, if the blossoms are allowed to remain upon the fruit spur and fruit is allowed to set, it is extremely rare for flower bud formation to take place. Three Duchess trees on which practically every fruit spur was carrying bloom were completely deflorated just prior to the opening of the blossoms. Check trees were allowed to set a full crop of fruit.

From two other similar trees a sufficient number of blossoms were removed so that every second spur bore fruit. The object of this experiment was to test whether or not the fruit spur acts as an independent unit. Far-reaching conclusions with reference to the feasibility of overcoming the well-known biennial habit of apple trees have been drawn by certain authorities on the basis that each fruit spur acts independently of the other fruit spurs on the tree. If this were true, one would expect the 50 per cent of the fruit spurs which were deflorated to produce as high a percentage of bloom as those fruit spurs on the trees in which all of the spurs were deflorated. In other words, the object of the experiment was to test whether or not the apples remaining upon 50 per cent of the spurs on the tree would prevent fruit bud formation on deflorated spurs on the same tree. In the spring of 1923 counts were made on the fruit bud formation of these trees and the results are given in Table I.

TABLE I.—*Per cent fruit bud formation on deflorated and bearing Duchess trees.*

Tree.	Treatment.	Number leaf buds.	Number flower buds.	Total number buds.	Per cent flower buds.
333	Deflorated	1022	1620	2642	61.3
468 *	Deflorated	1281	701	1982	35.4
493 *	Deflorated	3357	1282	4639	27.6
Average .....		....	....	....	41.4
334	Check	2238	152	2390	6.3
341	Check	2062	26	2088	1.3
465 *	Check	1724	177	1909	9.3
497 *	Check	2736	684	3420	20.0
Average .....		....	....	....	9.2
340	50% deflorated	1928	338	2266	14.9
499 *	50% deflorated	1865	112	1977	5.7
Average .....		....	....	....	10.3

* Spray burned.

An even greater difference would undoubtedly have appeared if it had not been for the fact that a portion of the trees in this experiment were sprayed with a tank of materials which the workmen had carelessly allowed to settle, with the result that the foliage on a number of the trees was severely burned at the time of petal fall. This appeared to cause a reduction of the leaf area on those trees which had previously been deflorated and very evidently reduced their fruit bud formation. On the other hand, a heavy drop of fruit was caused on those trees which would otherwise have had fruit on nearly every spur. This drop of fruit at this stage undoubtedly increased fruit bud formation on these check trees. The difference between the treatments, therefore, is not so great as it would have been if the spraying accident had not occurred.

It is interesting to note that those trees which were completely deflorated in 1922 produced a 41.4 per cent bloom in 1923, while those from which no blossoms had been taken in 1922 produced only 9.2 per cent bloom in 1923. The trees on which the bloom was removed from one-half the spurs produced 10.3 per cent of blossoms in 1923. While there were only two trees under the last treatment, the conclusion appears warranted that deflorated fruit spurs on a tree carrying a fair load of fruit do not have so great a tendency to produce fruit buds as have similar spurs on trees carrying no fruit. Measurements of the leaf area were also made on these spurs, and chemical analyses show very significant differences in the composition of the spurs under these different treatments. It is hoped that the work on this phase of the experiment may be completed and summarized for publication within another season.

Effect of Shading and Ringing upon the Chemical Composition of Apple and Peach Trees.

The analyses of shaded and unshaded apple and peach trees, ringed and non-ringed apple trees and alternate-bearing Yellow Transparent apple trees have been completed and the data published during the past year in the Annual Report of the American Society for Horticultural Science and Technical Bulletin No. 23 of the Experiment Station.

Winter Injury of Apple Roots.

Work on this project has been carried on by G. F. Potter along two lines: First, additional data on injury by low temperature to seedling apples under certain environmental conditions; and, second, microscopical studies of various types of injury to apple roots.

Observation in the field and, in a limited way, in experiment stations by scientific investigators, has established the fact that the roots of apple trees are more likely to be killed by cold in winter in a dry soil than in one that is partly or nearly saturated with water. Some question has been raised as to whether the greater injury in dry soil is due to the fact that, other things being equal, a dry soil is colder under given low air temperature than a moist or wet soil. In order to test this hypothesis, thirty-three lots of seedling roots were frozen while embedded in sand containing different amounts of moisture. The roots were placed within cylinders of sand and were so fastened into place that they were all at approximately equal distances from the outer edge. By the use of an automatic freezing apparatus, an air temperature of approximately -8°C . was maintained for nine hours. This period of exposure was sufficient to bring the sand in all the cylinders, wet or dry, to the same temperature as that of the air.

The resulting injury in eleven trials amounted to about 13 per cent less in the dry sand than in either the wet or medium moist sand.

The injury to the roots frozen in medium moist sand was essentially the same as that in very wet sand, but at the same temperature the dry sand appears to protect the roots. Records of the rate of fall in temperature within the different cylinders indicate that the temperature drops by far the most rapidly in the dry sand. Therefore, in a cold snap of short duration moist sand or soil would never get so cold as that with a low moisture content. This would seem to establish the fact that the greater injury to the roots of trees in dry soil is due to the fact that under exposure to a given low air temperature the dry sand would ordinarily become very much colder than the moist sand.

Twenty freezing tests were also carried on to give additional data on the relation of the rate of freezing to injury to apple seedlings. In this experiment seven lots of roots were frozen in air, the temperature of which was automatically allowed to drop about 1.25°C . per hour. In comparison, seven lots of roots were placed in an atmosphere at -8°C . and maintained at this temperature for a long enough period so that the entire root reached the temperature of the air. Under these conditions the live tissues of the root which are near its outer circumference must have dropped to a temperature of -8° almost instantly. A series of roots were placed in air at a temperature at about the freezing point, and the temperature of this air was then lowered to -8° in a period of from twenty minutes to one-half hour. The tissues of these roots would be frozen very much more rapidly than those in the first series, but not so rapidly as those which were placed instantly under a temperature of -8° .

The roots subjected to the slow rate of freezing showed injury of less than 70 per cent, while those frozen either medium rapidly or very rapidly showed an injury of approximately 94 per cent. It appears from these experiments that a drop in temperature occurring over a period of twenty minutes to one-

half hour is as injurious to the live tissues of the roots as at an almost immediate drop.

Some question has been raised by authorities on winter injury with reference to the relation of the size of root to the damage done at a given degree of temperature. While it is obviously true that roots which are several years of age do not suffer as much as younger roots at a given degree of temperature, and it is also true that the older roots are larger than the small roots, it may not necessarily follow that considering roots all of the same age the small ones will be found less resistant than the large ones. To test this matter, 500 apple seedlings all of one year of age were carefully tagged, calipered, and a record kept of the average diameter of each. They were then all subjected to a temperature of $-7.8^{\circ}\text{C}.$, this temperature being reached after a gradual fall of approximately 1.25° per hour. Records were then made of the per cent of injury to each and a correlation table constructed.

It was evident that there was no greater tendency for the small roots to be injured than for the large ones.

The second phase of investigation of this project, the microscopical studies, have not at this time progressed sufficiently so that conclusions may be drawn. A large amount of experimentation was carried on, using different killing fluids, including Fleming's Fluid of various strengths, picro-acetic, chrome-acetic, and Juel's fixatives. A killing fluid is desired which will properly fix the tissues without causing any discoloration that might be mistaken for injury by cold.

The stains used in the main were simple ones, and some of the best results were obtained from the use of Haidenhain's Haematoxylin contrasted with Orange G.

A paper giving some of the results on laboratory tests in freezing apple seedlings was read at the Boston meeting of the American Society for Horticultural Science, and further publication of these results is expected within the present fiscal year.

Root Maggot.

Since the last report the root maggot studies were concluded. The most important results, including the efficient and practical treatment for the cabbage root maggot, were published as Technical Bulletin No. 24, "Surface Treatments for the Cabbage Maggot."

European Corn Borer.

Beginning in the spring of 1922 a new Adams Fund project was started by W. C. O'Kane and P. R. Lowry (Entomology), on the life history, habits and means of control of the European Corn Borer. Extensive data were secured.

The work was laid out in consultation with the Bureau of Entomology, of the United States Department of Agriculture, which has been studying this pest under Massachusetts conditions for the last three years. The purpose of the inquiry is to discover accurately the details of the life history of this new species under New Hampshire conditions. Such knowledge is essential before measures for control can be recommended.

A large quantity of corn stalks containing hibernating larvae was secured in Massachusetts and brought to Durham. This furnished material for starting

the season's work. A screened house with a canvas roof was constructed especially for these life-history studies. This was placed so that it has natural shade. It proved successful in providing normal outdoor conditions where detailed studies could be carried out accurately and conveniently. A soil thermograph was installed and charts maintained throughout the season showing the temperature of the soil six inches below the surface. A station of Weather Bureau type was built, in which an air thermograph was placed, together with other instruments.

The infested material was brought to Durham before the close of the hibernating season. From this material records were made showing the beginning and the close of the pupal period for over-wintering larvae. It was found that pupation began May 11 and continued until the close of July. A large number of individual larvae were kept under observation.

From these pupae records of emergence of adults were secured together with data showing the length of the pupal period under New Hampshire conditions. The pupal period for males was found to be about twenty days and that for females about eighteen days.

Emergence of adult moths from the over-wintering larvae began June 2, and continued until the middle of August. Individual pairs of male and female moths were observed and notes secured on the preoviposition period, as well as the total longevity. The average life of the female moths from the over-wintering generation was found to be about eighteen days and that of the male moths about seventeen days.

The eggs laid by the female moths were recorded. The average number of eggs per moth was 451; the maximum number of eggs laid by a single individual was 1003.

In the course of this work it was found that a small percentage of over-wintering larvae failed to pupate or to continue their development, although remaining alive through the season. A somewhat larger percentage of pupae failed to develop to adult moths, but all such pupae died.

The eggs laid by the moths from the over-wintering generation were recorded and kept under observation. The length of the egg stage was found to vary, ranging from nine to twelve days, and this variation appears to be correlated closely with the temperature records for the period.

The larvae hatching from eggs described above constitute the second generation for the season; and these, in turn, were maintained under observation. Complete data were secured as to the length of the larval period and the length of time between molts. From these larvae further records were secured showing the length of the pupal period of the second generation, the beginning and end of the emergence period for adults, the length of the adult stage of the second generation, the length of the egg stage for this generation and the development of the larvae of the second generation, which, in turn, become the over-wintering form for this species. It was definitely established that in the locality of Durham the European Corn Borer can complete two generations in a year. This is in spite of the fact that the beginning of activity in the spring occurs later than the corresponding development in Massachusetts and in spite of the fact that development in the subsequent stages is delayed under the climatic conditions prevailing at Durham.

As the work developed, one locality was found where larvae could be observed and material secured under field conditions. This material was carried through separately from that described above and a start was made toward securing data on specimens that had originated under New Hampshire conditions. Careful and detailed observations were begun on the habits of the adults.

Three specimens of parasites were secured. Two of these were bred from pupae collected August 13 and August 23, on a farm at Stratham, N. H. One was bred from a larva from among the material brought from Massachusetts.

Sheep Breeding.

The flock developed from Southdown and Rambouillet parentage has now been cut down to 25 head; and while some further culling and selection will be necessary to perfect a uniform standard of appearance, it is the intention of E. G. Ritzman (Animal Husbandry), who has this work in charge, to maintain the flock at approximately this number. As an economic asset this new combination holds out good promise, since their average fleece weighed $8\frac{1}{2}$ pounds, graded as one-half blood staple and sold for top market price, while the male lambs of this cross (unselected) at 15 weeks of age averaged 67 pounds and sold for somewhat over nine dollars per head.

The first crop of F_1 has been obtained from the Rambouillet-Oxford cross. This cross will be used as a basis for developing the highly important economic traits of twinning and higher milk yielding capacity, which are, of course, the fundamentals essential to profitable lamb production for early markets.

As a great asset to the furtherance of this end one ram and five ewes have been obtained from the estate of Dr. Alexander Graham Bell, whose persistent efforts after 33 years of inbreeding have resulted in a breed of sheep possessing from four to six functional nipples and a relatively high degree of fecundity. It is hoped finally to transmit these two valuable characteristics on the flock originated here, thus finally combining reasonably good mutton conformation and high-grade wool with the factors that determine a profitable lamb crop.

A treatise on the inheritance of size and conformation in sheep has been issued this year as Technical Bulletin No. 25, and the material is being assembled for another on the inheritance of wool. After the technical phase has thus been covered on the inheritance of size, conformation, and wool, it is planned to prepare the results for publication in more popular form.

Nutrition Studies.

Results obtained during the first two years, suggesting a rather remarkable seasonal variation in heat metabolism on a constant feed level, was the cause of devoting the entire attention during the past year to the influence of environmental temperature.

This variation in heat metabolism on constant rations was rather unexpected. The uniform general drop in heat metabolized during the coldest part of the winter of 1918-1919 not only indicated a marked seasonal variation, but quite contrary to previous investigations on this subject the energy metabolism was lowest during the colder weather. This year's work was, therefore, planned to determine the influence of the environmental temperature both in the metabolism stalls and in the respiration chamber, allowing temperature as the only variable; feed, water, and general care remained as nearly identical as possible.

At the outset a number of unexpected influences, disturbing temporarily the heat metabolism, were encountered, such as sudden changes of environment, drinking large quantity of water, etc. While the results obtained show rather clear-cut contrasts of temperature effects, more investigation along this line will be necessary before it is advisable to draw any final conclusions.

The possible influence of temperature on the economy of feeding live stock has formed the basis of a number of feeding experiments contrasting the economy of feeding steers under open lot with more protected conditions; but there is practically nothing on record indicative of the influence of environmental temperature on basal requirements, *i.e.*, whether the energy requirements of feed are greater, or whether rations should be balanced differently in cold winter weather than during the more temperate seasons.

A technical treatise covering the first two years' work on the physiology of basal metabolism under submaintenance, maintenance, and fattening rations has been issued as publication No. 324 of the Nutrition Laboratory of the Carnegie Institution of Washington, which is co-operating in the work. This treatise, written by Dr. F. G. Benedict, director of the Nutrition Laboratory, and E. G. Ritzman of this Station, contains 42 text figures and 86 tables of data; presents many new physiological observations on the effect of different planes of nutrition on the vital activities of animals; and sets forth in a convincing way the remarkable facility with which animal life adapts itself to different standards of nutrition. Steers passing through a whole winter season in a state of undernutrition showed a capacity to pick up in spring and with equal opportunity to attain a marketable state of flesh with steers wintered under normal conditions.

Considerable evidence is also given on the extensive fluctuations occurring from day to day in live body weight, the factors that cause these variations, and the error in placing too great dependence on live body weight as a measure of the productive value of a ration.

Studies on the Effects of Fungicides and Insecticides on Plants.

Experiments have been made by O. Butler (Botany) for the purpose of determining the effect of the composition of Bordeaux mixture on the injury produced in the absence of rain or dew. The work was done with radish growing in normal light and heavy shade, but it was not found that the plants in shade were more sensitive than those in light, or that there was any correlation between the composition of the wash used and injury produced.

A Study of the Toxic Action of Fungicides to Parasitic Fungi.

The toxicity of the copper fungicides was particularly studied by O. Butler and W. L. Doran (Botany), and the work performed may be summarized as follows: The Uredinales are twice as resistant to the toxic action of copper as are other fungi. Urediniospores of these fungi are three times as resistant to copper as are aeciospores.

The conidia of *Venturia inaequalis* are very sensitive to copper—much more so than any other fungus spores studied.

Burgundy mixture is more toxic to the spores of *Alternaria solani* than is Bordeaux mixture, a result in harmony with data secured in field experiments.

RESULTS OF WORK IN HATCH AND STATE PROJECTS.

Effect of Disbudding on Apple Trees.

Owing to the widespread budding of fruit trees in New Hampshire by the ruffed grouse, an investigation of the effect of the removal of buds from fruit spurs upon the growth of the tree, fruit bud formation, fruit setting, and crop production was begun by G. F. Potter and H. A. Rollins last spring. In an orchard at Contoocook, two blocks of Wealthy were found nearly similar in age and situation, one of which had been budded by the birds and one of which had not. One hundred and sixteen trees from each orchard were labelled, and the diameter of each trunk was recorded. Since increase in trunk diameter is known to be correlated closely with the total growth of root and top of the tree, later figures may be expected to give some information as to whether or not the reduction in number of buds and consequent reduction in foliage of the tree have an appreciable effect upon its growth. Eleven trees were picked at random in each orchard for more detailed investigation. On these trees counts were made to determine the proportion of spurs which had formed blossom buds and on the disbudded trees the proportion which had been taken by the birds. The results on fruit bud formation are given in Table II.

It will be noted that the average percentage of buds removed on the trees in the disbudded plot was 51 per cent. This represents the budding in the winter of 1922-23. The proportion of fruit buds formed which would open in the spring of 1923 would not be influenced by the budding during the winter of 1922-23, but it is expected that it would be influenced by the budding during the previous winter. It is known that the orchard was budded during this, the winter of 1921-22, although no records of the exact extent of the budding are available. Some variation in fruit bud formation occurred between the different trees in the same orchards. This raises the question as to whether or not the eleven trees selected in each plot will be representative of the entire orchard. It is probable that they cannot be considered representative on a single year's data. For instance, in the non-disbudded orchard it will be noted that Trees 224, 268, 299 and 307 all produced a small proportion of bloom, although the majority of the trees in this orchard had at least 60 per cent or 70 per cent bloom. This error will be corrected after a second season, because the trees which in 1923 had less bloom than the average for the orchard will, in 1924, automatically have relatively more bloom. This is because of the known tendency of the Wealthy to blossom every second year. Observations on the per cent of set are given in Table III. These observations are of interest and of very probable significance even at this time. It is shown that the percentage of set is 71.8 on the trees which had been disbudded and 55.5 on the trees which had not been disbudded. It is known that the percentage of set decreases when the percentage of bloom on the tree is high; the percentage of bloom on the disbudded trees observed was somewhat higher than that on the non-disbudded trees; and we would, therefore, under normal conditions expect that the set would not be quite so good as on the non-disbudded trees which have a lower average per cent of fruit buds. The set, however, was practically 17 per cent better on the disbudded trees. It will be noted also that the average number of fruits per spur was 2.26 on the disbudded trees and 1.95 on the non-disbudded trees.

TABLE II.—Per cent of disbudding and per cent of fruit bud formation on *Wealthy* trees.

Disbudded.					Non-disbudded.				
Tree number.	Number blossom spurs.	Number non-blossom spurs.	Per cent blossom spurs.	Number disbudded.	Per cent disbudded.	Tree number.	Number blossom spurs.	Number non-blossom spurs.	Per cent blossom spurs.
17	54	2208	23.9	924	29.0	224	439	2038	17.7
20	773	343	69.3	1018	47.7	229	3271	106	96.9
23	516	161	76.2			232	1861	837	69.0
24	609	609	50.8	938	43.1	236	3834	430	89.9
59	420	213	66.4	1033	62.0	260	3186	1009	76.0
63	971	53	53.3	1515	64.8	264	4925	780	86.3
65	11	1820	60.1	1244	40.5	268	188	1537	10.9
82	1004	255	79.7	1193	48.7	272	1605	1208	57.1
99	1097	484	69.4	1572	49.9	295	1376	2571	34.9
102	782	206	79.2	1665	63.0	299	375	3121	10.7
105	1530	293	83.9	2149	54.0	307	547	2219	19.8
Total	7786	7443		14215		Total	21607	15856	
Average	707.8 ±91.7	676.6 ±148.1	64.7 ±3.5	1292.2 ±60.4	51.0 ±2.2	Average	1904.3 ±327.7	1441.4 ±192.0	57.7 ±6.9

TABLE III.—Per cent set on disbudded and non-disbudded *Wealthy trees*.

Disbudded.						Non-disbudded.					
Tree number.	Number blossom spurs.	Number spurs set.	Total number fruit.	Average set.	Average fruit per spur.	Tree number.	Number blossom spurs.	Number spurs set.	Total number fruit.	Average set.	Average fruit per spur.
17.....	54	35	61	64.8	1.74	224	439	273	683	62.1	2.13
20.....	773	603	1574	76.7	2.61	229	3271	1673	3864	51.1	2.30
23.....	516	324	788	62.7	2.46	232	1861	1069	2088	57.4	1.95
40.....	628	395	974	62.8	2.46	236	3834	2137	3812	55.7	1.71
59.....	420	368	827	87.6	2.24	260	3186	1854	3666	61.3	1.56
63.....	971	621	1365	64.0	2.10	264	4925	1935	2721	39.3	1.40
65.....	11	11	21	100.0	1.90	268	188	111	198	59.0	1.78
82.....	1004	518	1368	54.6	2.49	272	1665	997	1857	62.1	1.86
99.....	1097	925	2283	84.3	2.46	295	1376	801	1532	58.2	1.91
102.....	782	650	1355	83.1	2.08	299	1375	145	357	38.6	2.46
105.....	1530	752	1765	49.2	2.34	307	547	358	848	65.4	2.36
Total..	7786	5232	12321			Total..	21607	11453	21056		
Average.....	707.8 ±91.7	475.6 ±57.6	1120.1 ±139.0	71.8 ±3.2	2.26 ±.02	Average.....	1964.3 ±327.7	1041.2 ±173.1	1914.2 ±270.5	55.5 ±1.8	1.95 ±.68

Through an unfortunate misunderstanding with Mr. Robert Gould, owner of this orchard, the fruit was harvested and barreled without having been weighed and counted to determine the yield and average size fruit on each plot. The only record available on this part of the experiment is that given by Mr. Gould, who states that the 116 trees which were disbudded yielded 80 barrels of apples, of which 65 were A grade and 15 were B grade, while 130 trees in the orchard which was not damaged by partridges yielded 165 barrels, 133 A grade and 32 B grade. It is attested by Mr. Gould and several of his workmen that the size of the apples was better on the non-disbudded trees. This agrees with observations made by the Experiment Station staff in the orchards before the fruit was picked. The fruit on the budded trees was nearly all on tips of branches and there was a larger number of spurs which carried two apples per spur. This has a tendency to decrease the size of the fruit. Data on fruit bud formation, set, and crop, will be obtained in these orchards for at least one more season.

It now appears that for exact experimentation in this field the best plan would be to use an orchard so situated that it would never be budded by birds. Spurs could be cut from different plots in a manner similar to the way they are removed by the birds in feeding. By this means more accurate comparison of budded and non-disbudded trees under exactly the same conditions could be made. Also, the effect of budding for one season or for one or more seasons could be accurately compared. While there is some advantage in working with trees which have been actually disbudded by birds themselves, the grouse cannot be relied upon to furnish the proper experimental conditions regularly each season. However, to carry on such an experiment would involve very severe damage to any orchard in which the work was done, and the expense in remuneration to the owner would be greater than the Experiment Station can afford.

Variety Tests of Fruit.

Twenty trees of the Cortland variety were planted in the spring of 1923. In addition a few trees of the Nodhead variety which had been propagated in the college nurseries were also set. All made thrifty growth. Red Delicious fruited for the third successive season on the trees in the Thompson Orchard. The fruit harvested this season was larger and more uniform in size than that obtained in previous crops. This coincides with the observation in other orchards that the size of the fruit of this variety is smaller than normal when the tree first comes into bearing. The fruit was of good color, and of excellent quality. Golden Delicious produced fruit on top grafts in the orchards at the Horticultural Farm. The grafts were very productive, but the size was not large and appearance not very attractive. Under our conditions the variety has a tendency to produce a bronze-red blush instead of an attractive clear yellow. The quality of the apple is excellent.

There is no question but that the production of winter varieties of high dessert quality comparable to the fall McIntosh would be an advantage in this section. The two Delicious varieties appear worthy of test for this purpose. A plantation was made in the spring of 1923 containing fifty trees of each

variety, planted row for row alongside the old standard varieties, Baldwin and Wealthy. Cost accounts are being made on this orchard, and it is expected that at the end of ten or fifteen years the returns for each variety and the cost of the production may be compared.

The Stayman variety has been observed in several orchards in New Hampshire this season. Ordinarily the climate here has been considered too cool to produce a good quality of this variety. The apples in New Hampshire orchards this year are of small size and, compared to southern-grown Stayman, may be considered very small, although they would compare favorably with the good commercial size of Baldwin. The color was excellent, and the keeping quality appears to be very good. There is a possibility that this variety may be used to a limited extent in favorable localities in this state.

In the peach orchard the Carman variety proved hardiest in bud, having a full crop of peaches. The planting of Carman constitutes about one-fourth of the entire orchard and its crop constituted about one-half the total harvest. This peach has been found difficult to market by growers of intermediate Atlantic States such as Delaware and New Jersey, because it is a white peach competing with more attractive yellow varieties grown in the far southern states. The same condition was found to be true in the New Hampshire markets, and the peaches of this variety were difficult to dispose of. Foster is another white peach, which bore very heavily. There are only a few trees of this variety in the orchard, but its production per tree compared favorably with the Carman. In season it is later than the Carman, and has a more ready market. J. H. Hale produced a relatively small crop of very fancy peaches. These were large and of good quality, and found the most ready market of all varieties grown. Elberta produced a fair crop, possibly slightly lighter than that of J. H. Hale.

The Latham raspberry was set in the new raspberry plantation for trial in comparison with Herbert and other standard red raspberries.

Fertilizer on Strawberries.

In 1922 about .8 acre of Senator Dunlap strawberries was divided into sixteen fertilizer plots. Four treatments were given by S. W. Wentworth, each treatment being repeated in four different plots in different parts of the field in order to eliminate errors due to soil differences and moisture variations.

TABLE IV.—*Effect of nitrate of soda on yield of strawberries.*

Treatment.	Plots.	Yield in quarts on acre basis of each plot.				Average all plots.
200 lbs. nitrate of soda in fall plus same in spring...	1-3-10-12	3413.7	4770.6	2886.5	3854.5	3731
200 lbs. nitrate of soda applied in fall.....	2-4- 9-11	5029.9	4545.9	3059.4	3802.7	4109
200 lbs. nitrate of soda applied in spring.....	6-8-13-15	4407.6	4208.8	3284.1	3664.5	3891
Check plots (no fertilizer)...	5-7-14-16	3482.9	4148.4	4001.4	4641.0	4068

The results are shown in Table IV. The nitrate of soda produced no significant difference in yield. This experiment is of considerable interest, because

the practice of applying nitrate of soda to strawberry plants is not an uncommon one in New Hampshire. The results of this experiment being computed from the average of four different plots should be fairly accurate and should indicate a benefit from the practice, if any such existed.

During and just prior to the fruiting season, differences in the color of the various plots could be distinguished, those which received nitrate being darker green than those which received none. Samples were taken of one hundred leaves chosen at random from the nitrate plots and from the check plots. It was found that the area of the leaves from the high nitrate plots averaged 6.8 square inches, while on the check plots the average area of leaf was 5.8 square inches.

A similar experiment has been outlined on a strawberry bed which will fruit in 1924. Applications of nitrate made at intervals throughout the growing season will be compared with similar applications of acid phosphate and with applications of nitrate in the fall.

Observations were made on August 3 on the number of runners which had formed in proportion to the mother plants. Only two plots had received fertilizer prior to August 3, namely: the plot in which nitrate of soda was used at three different times during the growing season, and the plot in which acid phosphate is applied in a similar way. The number of runners per mother plant was found to be 1.21 on the plots which had received nitrate, 1.00 on the plot which had received phosphorus, and 1.25 and 0.9 respectively, on the plots which had received no fertilizer. It is apparent that there were no significant differences in the number of runners due to the effect of fertilizers. A number of strawberry crowns have been preserved in fixing solution for microscopical examination to study the time of fruit bud formation in the strawberry in New Hampshire.

Pruning Experiment with Apples.

The type of head pruning experiment has been carried on exactly as in previous seasons. The trees have now completed the fourth season of growth, and the semi-leader trees have all of the foundation branches which they are expected to carry permanently. From this date the leaders will be suppressed. The usual records have been taken on the amount of wood removed in pruning. Owing to the increase in size of the trees it is no longer feasible to measure the length of the twigs removed, but the branches have been weighed. Measurements of the increase in trunk diameter have also been made as an index of total growth of the trees. The data are given in Table V.

TABLE V.—Data on type of head pruning experiment.

	Vase.	Semi-leader.	Full leader.	Unpruned.
Diameter in inches close of 1922 season.....	1.64	1.74	1.73	1.07
Increase in trunk diameter during season of 1922.....	0.38	0.38	0.55	0.16
Weight in pounds of prunings removed spring of 1923.....	.429	.363	.380	....

There appear to be no significant differences in either the amount of wood removed in pruning or the growth of the trees. In most experiments the unpruned trees have been found to make a greater growth than those which have been pruned. In this experiment only a small number of trees have been left unpruned, and all of these, unfortunately, are unfavorably located with reference to soil and moisture conditions. The data from these unpruned trees are probably not of any significance.

Fertility in the Peach Orchard.

A crop of peaches was harvested in this orchard for the first time during the season of 1923. The average yields for the various plots, which include the Belle of Georgia, J. H. Hale, and Elberta varieties, were as follows:

- Plot 1. (Treatment: 200 lbs. Nitrate of Soda per acre), 3.7 ± 0.5 baskets.
- Plot 2. (Treatment: 200 lbs. Nitrate of Soda, 120 lbs. Muriate of Potash), 6.5 ± 0.4 baskets.
- Plot 3. (Check), 2.9 ± 0.3 baskets.
- Plot 4. (Treatment: 200 lbs. Nitrate of Soda, 350 lbs. Acid Phosphate), 1.9 ± 0.3 baskets.
- Plot 5. (Treatment: 200 lbs. Nitrate of Soda, 350 lbs. Acid Phosphate, 120 lbs. Muriate of Potash), 3.9 ± 0.6 baskets.

Close study of the orchard raises some question as to whether or not the plots on the northwest side are as favorably located as those in the central and eastern sides of the orchard. This difficulty common to all single plot experiments may vitiate the yield records on each specific treatment. However, the average yield of the plots which receive nitrogen was 4.0 baskets as compared to 2.9 baskets on the check. Records of diameter increase have also been made on this orchard and correspond to the differences in yield, in that growth has been greater on the trees receiving nitrogen.

Plant Breeding.

Sweet corn breeding which was begun under this project was not studied during the season of 1923. The seed is on hand and will be planted in 1924.

Maintenance of Soil Fertility in the Garden.

The soil fertility plots were planted by J. R. Hepler (Horticulture) to potatoes in 1923. The seed used was certified seed from New Brunswick, and there was no leaf curl or mosaic disease to limit the crop. On Plots 3 and 7, rye was sown in the fall of 1922 for a green manure crop. The plots are approximately seven-eighths acre in size, half of which is treated with 2000 pounds of lime every second year. All told, about 6000 pounds of lime have been applied, or just about the requirement for these plots.

Plots 5 and 7 dropped so low in yield in 1922 that an application of eight tons of manure per acre was made on them. This is the only fertilizer these plots have received since 1919.

The effect of chemicals on potatoes is shown by comparing Plots 1 and 5, which received only manure, with Plots 2, 4, and 6. Plot 1 received 32 tons, and Plot 5, 8 tons per acre. The manure plus fertilizer plots, 2, 4 and 6, showed

TABLE VI.—Yield of potatoes on garden soil fertility plots.

Plot.	Treatment.	Pounds yield potatoes on limited portion.	Pounds yield on unlimited portion.	Increase due to lime.		Total yield per plot. Pounds.	Increase over check.	
				Weight.	Per cent.		Weight.	Per cent.
1.....	32 tons manure per acre	1042.5	715.0	227.5	31.8	1757.5	43.0	2.5
2.....	24 tons manure per acre, 150 lbs. tankage, 100 lbs. nitrate of soda, 600 lbs. acid phosphate, 150 lbs. muriate of potash	1029.0	973.0	56.0	5.8	2002.0	287.5	16.8
3.....	Green manure, 250 lbs. tankage, 160 lbs. nitrate of soda, 500 lbs. acid phosphate, 300 lbs. muriate of potash	998.0	924.0	74.0	8.0	1922.0	207.5	12.1
4.....	16 tons manure per acre, 250 lbs. tankage, 160 lbs. nitrate of soda, 500 lbs. acid phosphate, 300 lbs. muriate of potash	1179.5	1147.5	32.0	2.8	2327.0	612.5	35.7
5.....	Check	945.5	769.0	176.5	22.9	1714.5	Check	
6.....	8 tons manure per acre, 250 lbs. tankage, 160 lbs. nitrate of soda, 500 lbs. acid phosphate, 300 lbs. muriate of potash	1177.5	1149.0	28.5	2.5	2326.5	612.0	35.7
7.....	Green manure	771.0	791.0	-20.0	-2.5	1562.0	-152.5	-8.9
Total.....		7143.0	6468.5	674.5	10.4	.....	.....	.....

increases of 16.8 per cent, 35.7 per cent and 35.7 per cent respectively. Green manure probably had very little effect, as Plot 3 only yielded 12.1 per cent over the check, and Plot 7, less than the check.

The limed plots outyielded the unlimed plots in every case except one where the decrease is not significant. On the other hand, the only significant increases were on Plots 1 and 5 where no commercial fertilizers were used. As a commercial proposition, liming was a total failure, as the potatoes on the limed portion were practically 100 per cent scabby.

Effect of Fertilizers on Vegetables.

In the squash fertilizer experiment approximately one-tenth acre plots were used. Each treatment was repeated four times by J. R. Hepler. The squash was planted May 26, and the manure put on the same day. The nitrate of soda was put on in two applications, the first on June 15 and the second July 2.

The soil used had been in crops for only two years, and the need of manure is apparent by a comparison of 1 and 2; the nitrate of soda did not produce the plant growth necessary for a good crop of squash. The effect of phosphorus is also very plainly shown by comparing Series 1 and 4 on the one hand, and 2 and 3 on the other; the differences of 1379 pounds and 1446 pounds respectively were probably both due to the influence of phosphorus.

TABLE VII.—*Effect of manure, nitrate of soda and acid phosphate on yield of squash.*

Treatment.	Plots.	Yield in pounds each plot.				Pounds total yield for four plots.	Average weight each squash.
20 tons manure per acre...	1-1a-1b-1c	429	770	438	594	2331	6.0
500 lbs. sodium nitrate, ...	2-2a-2b-2c	131	142	131	0	404	4.1
500 lbs. nitrate of soda, 1000 lbs. acid phosphate,	3-3a-3b-3c	754	451	331	314	1850	5.9
500 lbs. nitrate, 1000 lbs. acid phosphate, 20 tons manure.....	4-4a-4b-4c	938	1003	854	915	3710	8.2

There were fourteen rows of squash in each plot, of which the two center rows of the first two series of plots were treated with manure under the hill. The yields are given in the following table:

TABLE VIII.—*Effect of manure under hills on yield of squash.*

Plot.	Treatment.	Manure under hills. Average per row.	No manure under hills. Average per row.	Increase due to manure under hills.	
				Pounds.	Per cent.
1-1a.....	20 tons manure	128.0	70.0	58.0	82.1
2-2a.....	500 lbs. nitrate of soda	96.5	6.7	89.8	1346.0
3-3a.....	500 lbs. nitrate of soda, 1000 lbs. acid phosphate	287.5	62.5	225.5	456.0
4-4a.....	500 lbs. nitrate of soda, 1000 lbs. acid phosphate, 20 tons manure	235.5	122.6	112.7	90.0
Total.....		747.5	262.0	485.5	235.0

The increases are especially noticeable in Plots 2, 2a, and 3, 3a, where no manure was used. In the other two treatments where twenty loads of manure were used per acre the increases were much smaller.

The tomato experiment was continued by J. R. Hepler and H. R. Kraybill along the same line as the previous years. Four separate plots of 32 plants each were used for each fertilizer treatment.

Eight plants of each plot were measured every week during the growing season, by getting the length of the main shoot of the plant and the number and average length of the axillaries.

The effect of phosphoric acid in hastening the maturity of the tomatoes was again clearly shown. In plots where applications of 1000, 500, and 1500 pounds of acid phosphate were applied in addition to 20 tons of manure, increases amounted to 141.8 per cent, 77.9 per cent, and 163.8 per cent respectively over the check where 20 tons of manure alone were used. An increase to 40 tons of manure brought only 16.5 per cent.

Potash used in connection with phosphoric acid delayed maturity and decreased the yields, bringing an increase of only 9.4 per cent over the check as compared with 141.8 per cent where acid phosphate was used alone. A bulletin on the results of this experiment is planned for the coming year.

Tomato Selection Experiment.

The strain of tomatoes used at the University has been grown and re-selected in the greenhouse every year since 1914. In 1920, seed from the best plant was again selected by Mr. Hepler, and a whole greenhouse planted with it. Seed from these plants was used in the 1921 fertilizer experiment. It showed considerable variation in yield but very little in size and shape. Selections were made from the highest yielding and from the lowest yielding plants of each plot, in all thirty-two separate sub-strains. Analysis of the data shows the same range of variation in each sub-strain that was found in the parents. As to yield in 1922, the average yield per plant from the low-yielding plants was 68.7 ounces, from the high-yielding plants 67.0 ounces. In 1923 the low-yielding plants averaged 66.8 ounces and the high-yielding plants 65.3 ounces.

Tomato Variety Experiment.

In the variety test twenty-five different varieties of tomatoes were grown. Most of these are main season varieties and did not ripen much fruit. In this list may be found Hummer, Enormous, Golden Ponderosa, New Globe, Gulf State Market, Dwarf Champion, Dwarf Stone, Model, Early Detroit, McCullough's Special, Greater Baltimore, Wilt Resistant Marvel, Matchless, Nittany, and Matchum. The highest yielding variety was Avon, which is probably an early strain of Earliana, and ripened all its fruit amounting to about 2½ pounds per plant. June Pink also ripened about 2½ pounds per plant, but the fruit cracked so badly and was of such poor color that the variety seems hardly worth growing. John Bear and Penn State Earliana are very promising varieties. Hudson Valley Maid and Burbank followed the above varieties in amount of fruit ripening before September 20, also Chalk's Jewell, Ponderosa, and Acme.

Effect of Fertilizer upon the Composition and Storing Quality of Carrots.

Carrots were grown with an excess of nitrogen, phosphorus, potash and a combination of these elements. These carrots will be analyzed for their carbohydrates both before harvesting and during the storing period.

Timothy Selection.

In the experiment conducted by F. W. Taylor (Agronomy), to produce an improved strain of timothy, eighteen of the most ideal plants were selected in the testing plot of 1922. Seed from each of these was planted in separate rows in August. In June, 1923, one hundred plants from each of these rows were set out three feet each way in a new testing plot. On account of the extremely dry weather during June and July, about 80 per cent of the young plants died. It will, therefore, be necessary to start the testing anew from the same parent plants next season.

Of the plots which were put in by county agents in 1921, it was possible to locate and visit but one this season. On this plot, which was hardly fairly located (being near the top of a slope with the other plots below where there was more moisture), the timothy was earlier and leafier, but with shorter heads and not so tall as on the plots seeded with the Ohio and commercial strains.

Variety Tests of Ensilage Corn.

Seven varieties of ensilage corn were planted on one-twentieth acre plots June 2. The corn was harvested September 25. It was slightly frosted and somewhat dry at cutting time, so that the weights were a little lower than they would have been a week earlier. The results were as follows:

TABLE IX.

Variety.	Stage of maturity.	Yield per acre.
		Tons.
1. Golden Glow	Milk to dough	8.0
2. Duncan Corn	Well silked	10.0
3. M. A. C. Yellow	In milk	12.6
4. Certified Pickett	In milk	11.9
5. N. H. 500	Glazing	9.8
6. Silver King	In milk	12.9
7. Uncertified White Cap	Milk to dough	10.8

Soil Fertility.

The soil fertility plots, started in the fall of 1920 and outlined in our last report, were all in hay this year. These plots were carefully trimmed out, measured, and the air-dry weight of hay determined in the field. The plots varied much, and because of these variations the probable errors were too large to draw definite conclusions as yet regarding fertilizer treatments. In general, all plots showed a good increase in yield from plowing, liming and reseeded over the surrounding territory which had not been so treated. The plots varied in yield from 2495 pounds to 4866 pounds of air-dry hay computed to an acre basis.

The second set of duplicate plots, started in 1921 and virtually abandoned during the wet season of 1922, have this year been carried on practically in

accordance with the outline. Work was delayed on these plots a bit in the spring, and barley was substituted for oats as a nurse crop and to plow in. An excellent crop of buckwheat was grown this summer and utilized for green manure in accordance with the original outline. This set of plots is now all seeded to grass for next year's crop. The work is in charge of H. R. Kraybill (Agricultural Chemistry) and M. G. Eastman (Agronomy).

Potash Tests on Potatoes.

The series of potash tests on potatoes, begun in 1922 by F. W. Taylor, was continued in a similar manner. Quarter-acre plots were used. The potatoes were planted May 23-24 and were dug October 4-6. They were sorted over a standard grader. Owing to a drier and generally more favorable season, there was a smaller proportion of "Number twos" and "threes."

The following table shows the total yields per acre for the several treatments for 1922 and 1923 with an average for the two seasons:

TABLE X.

Fertilizer per acre.	Kind.	Bushels, 1922.	Bushels, 1923.	Average 2 years.
1200 lbs.	4-8-0	215.1	242.0	228.5
1200 "	4-8-3	215.7	252.5	234.1
1200 "	4-8-4	220.4	256.8	238.6
1200 "	4-8-6	246.6	226.0	236.0
1200 "	4-8-10	222.2	214.5	218.3
None	Checks	149.0	192.0	170.5

One reason why the yields of the last season do not show greater variation is probably due to the fact that the plots were on ground which had been well manured for corn in 1922 and again at the rate of 16 spreader loads per acre in the spring of 1923. While the results are not entirely consistent, they indicate that one season with another where manure is used for the potato crop the larger applications of potash are not desirable or profitable.

The seed used in the above tests was certified Green Mountain from New Brunswick. Certified seed from four different growers in New Hampshire was compared with this as well as with a good strain of non-certified home-grown seed:

TABLE XI.

Source of seed.	Yield per acre.
	Bushels.
1. N. H. Grown, certified	237.4
2. " " "	273.9
3. " " "	274.6
4. " " "	271.3
5. New Brunswick, "	275.8
6. Home-grown, non-certified.	248.0

It will be noted from the above figures that the certified seed produced approximately 25 bushels per acre more than the home-grown non-certified seed. On a ten-acre field this increase meant a net profit of about \$125.

Top-Dressing Hay Land.

The top-dressing tests of 1922 were duplicated by F. W. Taylor on the same quarter-acre plots in 1923. The grass was practically straight timothy and redtop. The top-dressing materials were applied May 4. The hay was cut July 12 and stored the 13th.

TABLE XII.

Fertilizer used.	Amount per acre.	Hay per acre, 1923.	Average, 2 years.
	Pounds.	Pounds.	Pounds.
Nitrate of soda.....	200	6480	5276
Sulphate of ammonia.....	150	6140	5106
Calcium nitrate.....	232	6088	5010
Acid phosphate.....	400	5420	.....
None.....	Checks	4952	4076

As an average of the past two seasons, one of which was very wet and the other very dry, the nitrogenous materials have increased the hay yield from 1000 to 1200 pounds per acre over the check plots. Although 400 pounds of acid phosphate increased the yield of hay 468 pounds per acre last season, this was more than one could expect as an average. The average increase for a period of nine years on similar soil at the college farm with an annual application of 400 pounds was only 60 pounds of hay, while the average increase for 200 pounds of nitrate for the same period was 1046 pounds.

The question of the economy of using fertilizing materials as top-dressing for hay land is a vexing one. Four important factors are concerned: namely, the cost of the fertilizers, the price of hay, the kind and condition of the turf, and the season particularly as regards rainfall. Obviously, if the price of fertilizers is high and hay is low, the average increase in yield will not pay the cost of fertilizer and the labor of applying it; if the season is very wet, good yields of hay will be secured without top-dressing; if very dry, the effect of the fertilizer is lessened. If the turf is old and composed mainly of wild grasses, the increased yield is not likely to be appreciable. On the other hand, with a comparatively new sod in a normal season with hay and fertilizer at something like a parity of price, the use of nitrogenous materials like nitrate of soda or sulphate of ammonia will prove profitable.

Pasture Improvement.

The eight one-eighth acre sections of pasture land laid out in 1922 were continued. Additional applications of nitrate of soda and nitrate of lime were made in the spring. No additional limestone or grass seed was added. The effect of the fertilizers was noticeable throughout the season, and the sections which had received grass seed the previous season were apparently improved.

It is planned for next season to lay out a much more extended and comprehensive series of experiments on a 40-acre pasture recently acquired on the Foss Farm.

Alfalfa.

A one-acre plot of alfalfa was seeded this season with certified Grimm seed. The land was a clay loam and was in corn in 1922. It was fall-plowed, and

a coat of manure was harrowed in in the spring. Chemical tests showed the land to be strongly acid, and $3\frac{1}{2}$ tons of ground limestone were applied. A strip, however, through the centre of the piece was left unlimed. The land was inoculated with soil from an old bed of sweet clover. The soil was applied with the fertilizer sower. An uninoculated strip was left through the centre of each half. In order to note the effect of different methods of seeding, one-half of the plot was seeded June 16 with oats as a nurse crop and the other half August 3 without a nurse crop. The oats were cut for hay August 8. Both halves went into winter quarters in good condition with a very uniform stand.

Foreign Clovers.

The small plots of clovers seeded in the grass garden in 1922 developed reasonably well and fairly uniformly with the exception of the Hungarian, reports F. W. Taylor. The Hungarian never developed more than one-half of a good stand, possibly due to poor germination. The winter proved rather disastrous to these clovers. Practically none of the foreign clovers survived and even the two local varieties were much thinned out. The few plants that came up this spring among the foreign clover plots showed evidence of having developed from stray seeds of native clover rather than from the imported seed. The plots of local seed developed only very mediocre stands this summer, and our conclusion is that these plots must have been exposed to rather severe changes in winter temperature in spite of the general heavy snow-covering, possibly due to their location on a knoll subject to considerable sweeping by the wind. However, the indications are that the local clovers were more resistant to the rigors of winter than any of the foreign varieties, as these two varieties were planted on either side of the foreign plots and both gave a partial response this season.

Effect of Climate on Productiveness.

The data secured during the year on this project were in substantial agreement with that obtained the previous season, reports O. Butler. Seed of the same strain of potatoes is being grown simultaneously in Maine and New Hampshire, the object being to determine whether deterioration actually occurs in southern New Hampshire and if so, what form it takes. In 1921, the New Hampshire grown seed yielded 1.83 times less than the Maine grown seed, and in 1922, 1.49 times less. The above figures are remarkably consistent and might be taken as giving substance to the belief that potatoes in southern New Hampshire do run out; but to interpret them in this manner would be to give them too much weight. They actually show that potatoes may run out, but no other conclusion can be safely drawn from them.

Spraying Potatoes.

An experiment was carried out with 8-4-50 Bordeaux mixture for the purpose of studying the effect of number of nozzles, pressure and size of caps on control of late blight, but the results obtained were questionable, since most of the rotten tubers found were in those parts of the field in which the grower was troubled with rather a heavy growth of witch grass.

Snapdragon Rust and its Control.

As reported in Technical Bulletin No. 22 this year, it was found by O. Butler that snapdragon rust could be controlled by sulphuring in a warm greenhouse. On plants set out in the open, sulphur could not control the disease, even though a temperature of 22° C. or above was maintained for at least four hours each day by being moved into the greenhouse when the temperature outdoors failed to reach the desired point or did not remain at it long enough. The healthy plants in the greenhouse remained so free from disease that they outgrew the inoculated ones more than twenty times measured in terms of green weight.

It was also found that plants growing in the field can be protected from the snapdragon rust if they are covered by bell jars at night.

Two rows of snapdragon plants were set out on the north side of the house, but exposed to the morning and evening sun. Plants inoculated with rust and healthy plants were planted alternately in the rows. The experiment was begun on May 27 and ended on August 28, the plants being dusted twelve times during the course of the experiment with superfine flour sulphur. In one row the healthy plants were covered with bell jars at night, and in the other the rusted plants were so covered. The bell jars were removed between 8 and 9 o'clock in the morning, except on one or two occasions when the weather was wet and cold. The healthy plants covered with bell jars grew nicely and remained free from rust; the diseased plants covered with bell jars were badly rusted, but possessed some clean foliage and had a mortality of 33 per cent; the healthy plants not covered were all badly rusted and 50 per cent died; the rusted plants uncovered were either dead or dying, 83 per cent being actually dead on August 28.

Sooty Mould.

An attempt was made to control this disease by dusting with sulphur and spraying with calcium polysulphide. The fungicides were applied as soon as the fungus was noticed on the fruit. Both methods were beneficial, and the fruit harvested from the dusted and sprayed trees was more acceptable to the trade than that from the non-treated trees.

Apple Scab.

The experiments on the control of apple scab were continued. An attempt was made to determine the minimum strength of Bordeaux mixture that could be used and satisfactory control obtained. Less than 0.5 per cent Bordeaux mixture did not give satisfactory control.

Miscellaneous Potato Experiments.

In the course of the work on potato improvement, O. Butler carried on experiments in order to determine the effect of spindling sprout on yield, the effect of the corrosive sublimate treatment for rhizoctonia on regularity of stand, the effect of removing net-necrosis tubers on percentage of leaf-roll, and for the purpose of studying the relative fertility of seed pieces cut from the stem-end and bud-end halves of the potato respectively.

1. *Effect of Corrosive Sublimate Treatment on Stand.*

The regulation treatment with corrosive sublimate, *i.e.*, submersion of the tubers, even after they have begun to sprout, in a solution containing 4 ounces of corrosive sublimate in 30 gallons of water for 1½ hours, was not found to affect the stand. The treatment is entirely harmless whether the potatoes treated are quite flabby or firm. Irregularities in stand sometimes complained of by farmers who have used corrosive sublimate are due to other causes.

Since corrosive sublimate dissolves more readily when mixed with its own weight of common salt, this practice was also studied and found entirely harmless.

2. *Effect of Spindling Sprout on Yield.*

Spindling sprout tubers were selected from seed placed to green in bright diffuse light. The potatoes selected showed no signs of net-necrosis. The sprouts were removed before the seed was planted. The stand obtained was 86.1 per cent perfect, and 93.5 per cent of the plants grown showed symptoms of leaf-roll. The plants yielded on the average 0.42 pounds per hill, the crop being composed mostly of tubers of non-marketable size.

Thirty-one plants produced 13 pounds of tubers, which graded as follows:

Tubers less than 2 ounces in weight, 67.3 per cent.

Tubers 2 to 12 ounces in weight, 32.7 per cent.

3. *Effect of Net-Necrosis on Development of Leaf-Roll and Yield.*

In this experiment tubers were selected from a random sample of Green Mountain seed, in which about 20 per cent of the marketable tubers showed net-necrosis. Four rows of the 36 hills each were planted as follows:

Row 1. Bud-end of tubers showing net-necrosis only at the stem-end.

Row 2. Bud-end tubers free from net-necrosis.

Row 3. Stem-end of tubers, net-necrosis in each seed-piece.

Row 4. Stem-end of tubers, seed-pieces free from net-necrosis.

The figures given in the following table show that leaf-roll can be reduced by eliminating tubers affected with net-necrosis, but that if net-necrosis is present in a large percentage of tubers the stock should not be used for seed.

TABLE XIII.—*Effect of net-necrosis on stand, percentage of leaf-roll and yield.*

	Stand.	Leaf-roll.	Yield by hill.	Tubers less than 2 ounces.	Tubers 2 to 12 ounces.
	Per cent.	Per cent.	Pounds.	Per cent.	Per cent.
Row 1	100.0	97.2	0.59	33.72	66.28
Row 2	94.4	55.9	1.03	18.43	81.57
Row 3	88.8	78.1	0.81	16.35	83.65
Row 4	100.0	50.0	0.82	17.80	82.20

4. *Relative Fertility of Seed Pieces from the Bud-End and Stem-End of the same Tuber.*

Certified Green Mountain seed potatoes were cut in half across the middle. The bud-ends and stem-ends were then cut into chunky seed pieces, but the work was done with no more than the usual care exercised in practice. The

seed was planted as soon as cut in a large potato field by means of a planter, the stem-end and the bud-end pieces in contiguous rows. The plants were given the same care during the growing season as the field proper. The size of the plots was one-seventeenth of an acre.

The stand obtained was the same for both kinds of seed and so also was the general appearance and vigor of the plants. The following yields were obtained:

Seed pieces from bud-end of tuber, 402.46 bushels per acre.

Seed pieces from stem-end of tuber, 394.41 bushels per acre.

Evidently all parts of the tuber are equally fertile.

Control of Termites.

The record of this project was published as Bulletin No. 204. The project developed a new and efficient means for the eradication of termites in the timbers of buildings.

Insect Record.

The complete set of records maintained by the Entomology Department has been maintained, and interesting facts have been added. The native stalk borer, *Papaipema nitela*, continues to be abundant. It is very generally confused with the European Corn Borer. The numbers of the browntail moth, *Euproctis chrysorrhoea*, continue to increase. There was extensive feeding by the gipsy moth in certain localities, but this was followed by rapid development of the so-called "wilt disease" among the caterpillars.

Studies upon the Lime Requirement of New Hampshire Soils.

The work upon this project was continued by H. R. Kraybill and C. P. Spaeth in co-operation with the county agents along the same lines as the past two years. During the past season 266 samples were tested, in addition to about 100 samples sent in by individual farmers and about 80 samples collected from legume demonstration plats.

The following table shows the summary of the results obtained from the test carried on in co-operation with the county agents for the past three years (Table XIV).

Methylene Blue Project.

Investigations of the methylene blue test by J. M. Fuller and H. F. DePew (Dairy Husbandry) have indicated that the test gives a satisfactory index of the keeping quality of milk. The relation between the reduction time of the methylene blue test and the number of bacteria as shown by the plate method is only fairly definite. This relation may be expressed thus:

Reduction time 3 hours or less, 500,000 or more bacteria per cc.

Reduction time 4-7 hours, 150,000 bacteria per cc.

Reduction time 8 hours or more, less than 25,000 bacteria per cc.

It has been found that there is no definite relation between the acidity of milk and the bacterial count. Each of four samples of milk in one group of 13 showed 18 per cent acidity. The bacterial count of these four samples was 190,000, 65,000, 485,000 and 3,500 respectively. Again each of two samples

TABLE XIV.—*Results of lime tests.*

County.	Number of samples.				Acreage represented.				Average lime requirement by Truog test for crop intended to be planted in pounds ground lime-stone per acre.		
	1921.	1922.	1923.	Total.	1921.	1922.	1923.	Total.	1921.	1922.	1923.
Merrimack.....	93	88	52	233	255	268	159	682	5500	4000	4500
Belknap.....	52	22	...	74	345	33	...	378	6000	6500	...
Strafford.....	39	10	48	97	188	...	91	279	5300	...	4416
Rockingham.....	35	71	135	241	60	235	263	558	6500	5600	4762
Sullivan.....	10	...	6	16	10	...	35	45	6000	...	3143
Hillsborough.....	23	48	12	83	121	232	20	373	6000	4000	4636
Carroll.....	...	60	10	70	...	452	21	473	...	4200	3600
Grafton.....	...	36	...	36	...	259	...	259	...	3000	...
Cheshire.....	...	...	46	46	...	...	100	100	...	...	3912
Total.....	252	335	309	896	979	1479	689	3147			

showed 21 per cent acidity. The bacterial count was 120,000 and 8,500 respectively. Data also indicate that there is a lack of definite relation between initial acidity and keeping quality.

Forest Research.

The forest plots were remeasured during the past year by K. W. Woodward (Forestry), and several new ones to determine the effects of thinning will be established this coming year.

MISCELLANEOUS INCOME PROJECTS.

Under this head come the analysis work conducted for the State Department of Agriculture, the Advanced Registry tests and other projects which are largely self-supporting.

White Diarrhea Work.

The number of blood samples taken during the past year was the largest since the beginning of the work five years ago, amounting to 40,000, reports A. W. Richardson (Poultry Husbandry). It is probable that this is the "peak" of the campaign. The number of flocks on the accredited list has now increased from 23 to 39, which it is estimated will produce 880,000 disease-free chicks during the year. With this volume of healthy stock permeating the state, it is believed that the number of tests necessary will decrease somewhat from now on.

A new Ford coupe was purchased and an electric oven was added to the equipment, thus facilitating greatly the handling of the large number of samples.

Advanced Registry.

The number of cows on yearly test increased from 238 to 289 during the year. These were divided as follows by breeds: Ayrshires, 46; Guernseys, 104; Holsteins, 49; Jerseys, 68; and Shorthorns, 22. The number of seven-day tests decreased from 27 to 14.

Potato Seed Certification.

Work was continued by O. Butler toward building up a supply of high-grade certified seed potatoes within the borders of the state. Thirteen and one-half acres of Green Mountains passed certification in 1922 out of a total of thirty-four acres submitted. The gross yield of the fields that passed inspection was 4378.9 bushels, which is a mean yield of 324.3 bushels per acre.

Feed Inspection.

Two hundred and sixty-one samples of commercial feeding-stuffs were analyzed for the State Department of Agriculture in connection with the enforcement of the state law regulating the sale of these materials. The results of this inspection are reported in Bulletin No. 209. The relative number of feeds in the respective classes is similar to that of the past two seasons. There is a decrease in the number of oil meals and an increase in the number

of dairy feeds. The quality of the feeding-stuffs shows a slight improvement on those of two years ago. The deficiencies in guaranteed analysis are less frequent than in those of the preceding two years. Only two per cent of the samples were seriously deficient in both protein and fat.

Inspection of Commercial Fertilizers.

One hundred and one samples of commercial fertilizers were analyzed for the State Department of Agriculture. The results of this work are reported in Bulletin No. 210. There were fewer deficiencies in guaranteed analysis than during the preceding two years. There is still room for improvement. These deficiencies indicate the importance of studying the bulletin and buying from those companies whose fertilizers meet the guarantee. There was a slightly larger proportion of high analysis fertilizer than last year.

Seed Testing.

Seed tests were conducted as usual for the official inspection work of the State Department of Agriculture. In addition, numerous samples have been tested for farmers, county agents and seed dealers. A total of 553 samples was handled by the seed laboratory during the year.

FINANCIAL STATEMENT.

A statement of the sources of income and expenditures during the fiscal year 1922-1923 follows:

FINANCIAL REPORT TO THE UNITED STATES GOVERNMENT OF THE HATCH AND ADAMS FUNDS.
For the Fiscal Year Ending June 20, 1923.

	Hatch Fund.	Adams Fund.
DR.		
Receipts from the Treasurer of the United States, as per appropriations for fiscal year ending June 30, 1923.....	\$15,000.00	\$15,000.00
CR.		
By Salaries.....	\$10,251.00	\$11,110.00
Labor.....	644.75	1,302.05
Publications.....	1,198.50	
Postage and stationery.....	209.66	6.30
Freight and express.....	263.67	82.37
Heat, light, water, and power.....	600.00	
Chemicals and laboratory supplies.....	198.10	455.43
Seeds, plants, and sundry supplies.....	204.26	174.27
Fertilizers.....	149.02	
Feeding-stuffs.....		551.58
Library.....	294.55	
Tools, machinery, and appliances.....	101.91	204.34
Furniture and fixtures.....	56.43	11.30
Scientific apparatus and specimens.....	187.50	579.49
Live stock.....		
Traveling expenses.....	639.61	15.33
Contingent expenses.....		
Buildings and land.....	1.04	507.54
Balance.....		
Total.....	\$15,000.00	\$15,000.00

SUPPLEMENTARY STATEMENT OF FUNDS RECEIVED FROM OTHER SOURCES THAN THE
UNITED STATES.

For the Fiscal Year Ending June 30, 1923.

	State.	Sales.	Miscellaneous income.	Total.
DR.				
To balance on hand.....		\$342.38	\$1,211.58	\$1,553.96
Receipts from other sources than the United States for the year ended....	\$7,000.00	768.85	13,958.89	21,727.74
Total.....	\$7,000.00	\$1,111.23	\$15,170.47	\$23,281.70
CR.				
By Salaries.....	\$4,992.00		\$5,070.47	\$10,062.47
Labor.....	218.68	\$423.50	3,767.38	4,409.56
Publications.....	653.29			653.29
Postage and stationery.....	318.55		248.32	566.87
Freight and express.....	55.00	86.30	68.40	209.70
Heat, light, water, and power.....				
Chemicals and laboratory supplies.....	165.54	1.58	667.74	834.86
Seeds, plants, and sundry supplies.....	100.01	272.35	1,045.20	1,417.56
Fertilizers.....	26.00		26.00	52.00
Feeding-stuffs.....		301.41	103.46	404.87
Library.....	95.12		171.40	266.52
Tools, machinery, and appliances.....	121.17	2.50	915.84	1,039.51
Furniture and fixtures.....	3.33			3.33
Scientific apparatus and specimens.....	160.86		297.38	458.24
Live stock.....		301.00	87.50	388.50
Traveling expenses.....	90.45		1,148.02	1,238.47
Contingent expenses.....			48.55	48.55
Buildings and land.....		72.75	167.95	240.70
Balance.....		—350.16	1,336.86	986.70
Total.....	\$7,000.00	\$1,111.23	\$15,170.47	\$23,281.70

